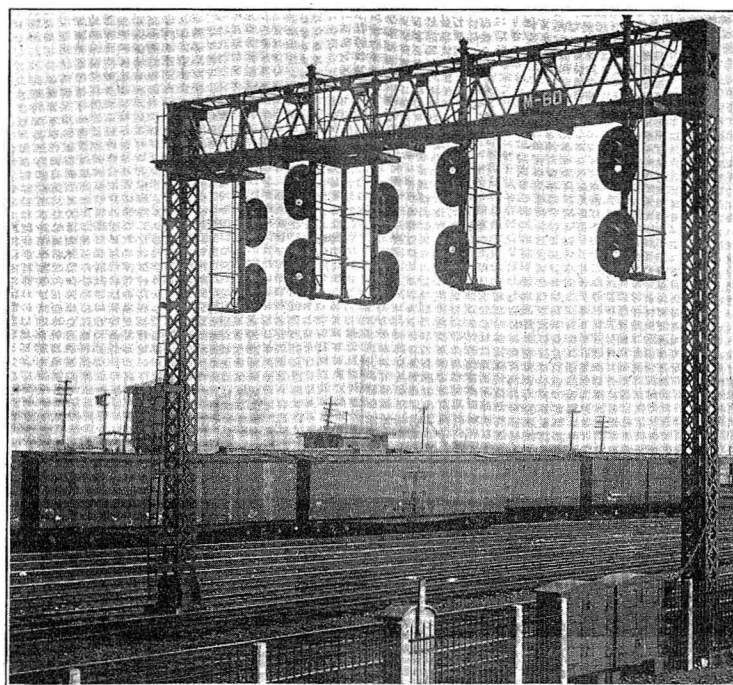
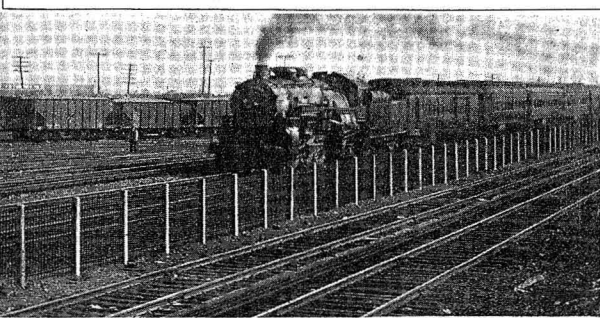


# Signaling Meadows Line of D.L.&W.



Heavy Traffic Handled by Means of Modern Interlockings and Signaling With a New Fourth Indication



*Looking East from Harrison Towards Kearny Junction*

**T**HE Delaware, Lackawanna & Western delivers over 60,000 people every week day to its Hoboken terminal. These people are, to a large extent, commuters who take the Lackawanna ferries or the Hudson & Manhattan tubes from Hoboken to various terminals in New York City. In the evening, the commuters are returned to their homes throughout a considerable section of northern New Jersey. Two hundred fifty scheduled trains are run on week days and 108 on Sundays. To handle traffic of this nature safely and without delays forms one of the greatest problems in modern railway operation.

## Track Facilities and Interlockers

The Hoboken terminal has 16 platform tracks. Two large electro-pneumatic interlocking plants control train movement on the six through tracks, converging to four tracks through the Bergen tunnel. Three of the last mentioned tracks are signaled for traffic in both directions, thus allowing four tracks to be utilized for traffic in a single direction during portions of the day when this is advantageous.

An electro-pneumatic interlocking at West End controls train movements to and from Bergen tunnel and the junction of the two main lines—one four track westward towards Boonton, and one three-track leading southwest to Morristown, Montclair and Gladstone. Practically 80 per cent of the passenger traffic is handled over the latter line, while most of the freight trains are sent over the former, largely because of extensive yards and other facilities at Secaucus.

The signaling which has been installed recently extends from West End interlocking to Newark interlocking—a distance of 5.9 mi. The accompanying track and signal plan, Fig. 1, indicates, to some extent, the nature of this work. Electro-pneumatic interlockings were installed in place of the older mechanical plants at Hackensack drawbridge, Kearny Junction, Harrison and New-

ark. A mechanical interlocking plant which was in service at Passaic drawbridge was reduced in size so that it now handles only a freight lead occupying the lower deck of the bridge, while the units governing train movement over the double track on the upper deck are controlled and operated from the Newark interlocking machine.

The four tracks from the tunnel through West End interlocking converge to three and then to two, which pass over Hackensack drawbridge. Three tracks are provided from this drawbridge through Kearny Junction and Harrison interlockings to within about 1,600 ft. of the Passaic drawbridge. The double track over this bridge joins to three tracks at the west end, this junction being handled by the Newark interlocking. Tracks 1 and 3 are signaled for traffic in both directions; track 2 has signals for eastward trains only. The changes in number of tracks and reversals of normal direction of traffic necessitate the interlocking of switches and signals throughout this section.

Through passenger and suburban express trains pass through the newly signaled zone without stopping, and usually at speeds of from 30 to 50 mi. an hr. Some of the local suburban trains stop at Harrison station, between Harrison tower and the Passaic river. No other regular stops are made. Freight trains are moved into and out of Harrison yard, and freight cars are delivered to industries west of Hackensack draw, near Harrison, and in Newark. Movements are also made from the main tracks at Harrison to the lower deck of Passaic drawbridge. Interchange tracks connect with the Pennsylvania at Kearny Junction.

A record taken on an ordinary week day showed 228 trains in 24 hr., or one train for each  $6\frac{1}{3}$  min. in one or the other direction on one of the three tracks. As a matter of fact, these trains are bunched so as to require that they run on the same track with the headways from two to six min. during the rush hours at morning and evening. For an average length block (1,930 ft.), from

which the variation is not great), trains operated on a two-minute headway must run at:

- 36 miles an hour on "clear" signal indications;
- 25 miles an hour on "approach restricting" signal indications; and
- 14.3 miles an hour on "approach" signal indications.

### Opening Drawbridges Interrupts Schedules

Freedom from traffic congestion cannot be secured on this section of track even by the most careful adherence to the schedule for trains or the most perfect train dispatching, as the drawbridges at the Hackensack and Passaic rivers must allow uninterrupted boat traffic in accordance with the government marine regulations. Occasionally this interferes seriously with train operation, especially when a bridge is opened during rush hours. The trains on from two to six minutes headway will close in and occupy from a half mile to a mile of track, waiting for a bridge to be closed. To witness the rapidity with which the road is freed of congestion of

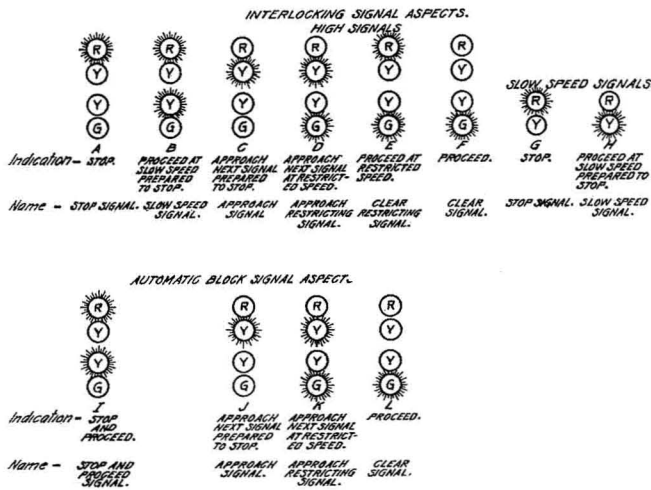


Fig. 2—Interlocking Signal Aspects

Fig. 3—Automatic Block Signal Aspects

this nature will convince one of the necessity for providing the most complete signal facilities.

Trains can be operated eastward on three tracks or westward on two tracks simultaneously. It is not so essential that westward trains, which are just starting on their runs, be kept exactly on time, as it is that eastward trains be not delayed, as the latter are approaching the terminal and have boat and subway connections to make. With signals 1,930 ft. apart a train can follow a train safely at a headway as low as two minutes. As a result of the signal facilities provided, 95.3 per cent of the eastbound trains have been normally reaching the terminal on time, in spite of unavoidable drawbridge delays.

### Developments and Changes Required

Ten years ago there were only two tracks across the Meadows and traffic on these was protected by two-position, two-arm semaphore signals, spaced approximately 3,500 ft. apart. The number of trains increased until there was a serious traffic delay in normal operation, so that it became necessary to cut the blocks in half, making these about 1,750 ft. long. To be safe, it was necessary to have two caution signal indications for each stop indication. As traffic increased, a third track became necessary and a system of signals was installed with this which provided for the first time on the Lackawanna a differentiation between "approach" and "approach restricting" signals. A comparison of the interlocking

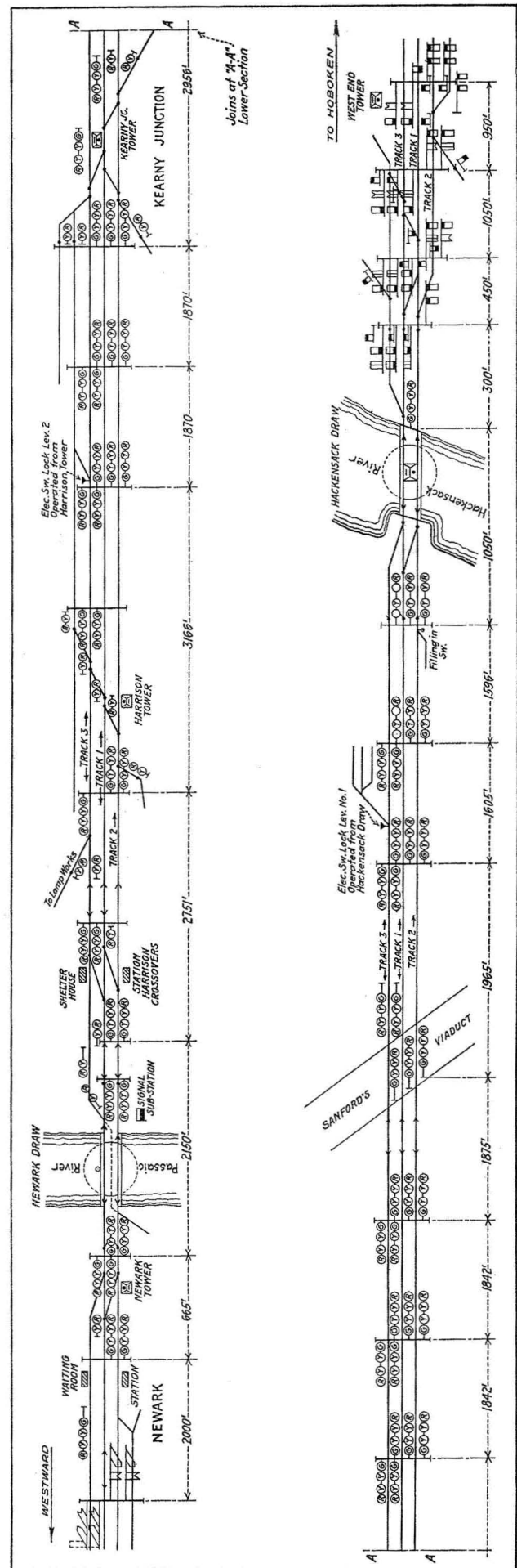


Fig. 1—Signal Location Plan, Showing Tracks and Signals Between West End and Newark—Upper Section Joins Lower at Left

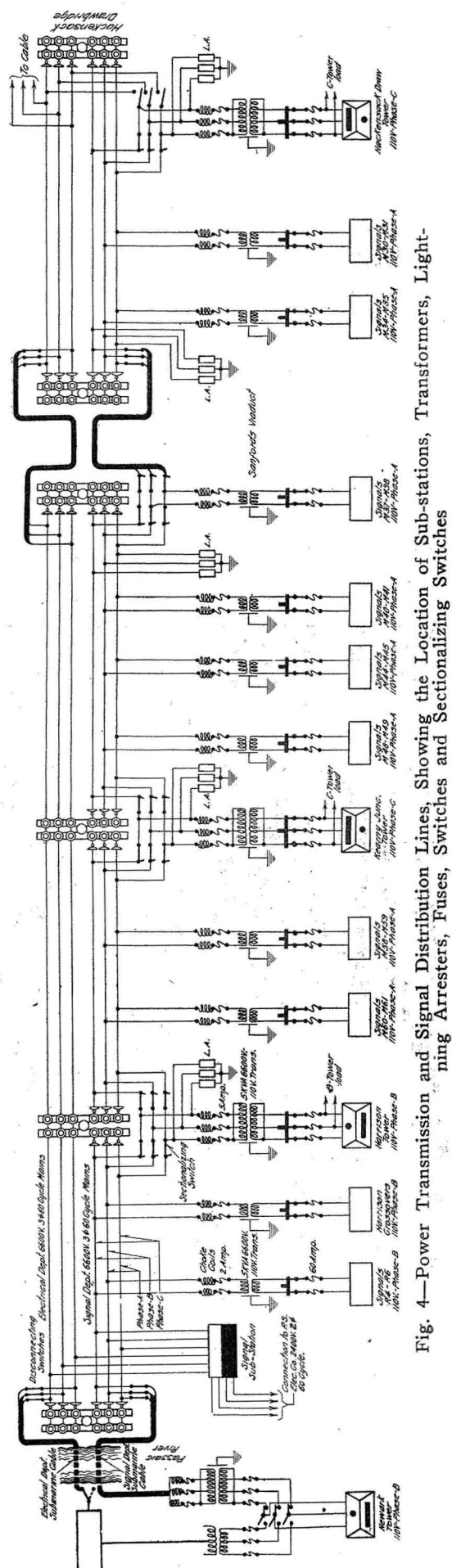


Fig. 4—Power Transmission and Signal Distribution Lines, Showing the Location of Sub-stations, Lighting Arresters, Fuses, and Sectionalizing Switches

units and automatic signals before and after the addition of the third track and subsequent changes is indicated in the tabulated form below:

#### Old Layouts

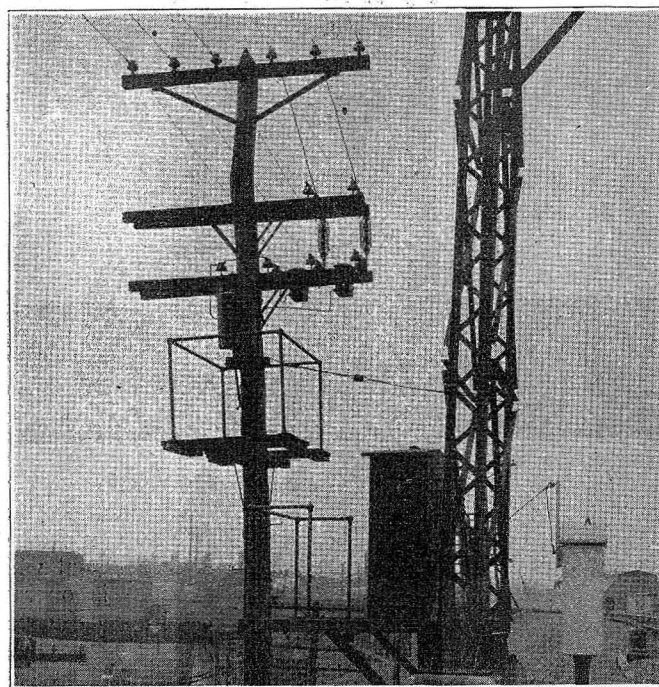
	Intlg. Levers	Oper. Units	Sigs.	Sw. and Derails	F.P.L.	Other Locks
Hackensack draw...	12	12	5	3	2	2
Kearny Junction...	41	35	18	8	9	..
Harrison .....	25	25	15	4	5	1
Newark draw.....	17	17	6	4	4	3
Newark .....	20	13	8	2	3	..
Automatics .....	..	31	31	..	..	..
Total .....	115	133	83	21	23	6

#### New Layouts

	Interlocking Levers	Working Levers	Operating Units	Ground Signals	Bridge Signals	Dwarfs	Switch and Draws	Switch and Bridge Locks	Traffic Levers
West End (added).....	..	..	5	..	1	2	..	..	2
Hackensack draw .....	19	15	23	..	4	1	7	2	5
Kearny Junction .....	19	15	33	2	3	5	14	..	4
Harrison .....	23	22	47	..	9	9	15	1	4
Newark draw .....	8	8	8	2	..	..	2	4	..
Newark .....	27	20	28	..	8	1	7	1	3
Roseville Avenue .....	..	..	1	..	..	..	..	..	1
Automatics .....	..	..	43	7	36	..	..	..	..
Total .....	96	80	188	11	61	18	45	8	19

#### Signal Aspects and Indications

The adoption of color-light signals for the Meadows installation is a departure from past practice on the



Transformer Located at Signal Bridge, the Three Wires on the Right Are Signal Power Lines. Note the Open Reactance Coils Used for Lightning Protection

Lackawanna. Interlocking signal aspects and indications are shown in Fig. 2; automatic signal aspects and indications in Fig. 3. This general scheme of aspects not only provides for closing in of traffic safely by qualifying the "caution" indication, but has also reduced the number of indications formerly used from 36 to 12. A number of dwarf signals, required by the older scheme, at the base of high signals, have been eliminated.

The greatest variation from past practice in signal in-



dications exists in the introduction of the aspect *D* and *K* which indicates "approach next signal at restricted speed." Thus a "stop" signal, *A*, or a "stop-and-proceed" signal, *I*, will be preceded by an "approach" signal, *C* and *J*, before which will be an "approach-restricting-signal" *D* and *K*. This arrangement provides for signals to be spaced less than braking distance apart and yet allows



Two-Arm Style-L Ground Signal at Sanford Crossing

trains to be run at a maximum speed. Trains at lower speeds may close in, one train following another under the indication shown in *C* and *J*. This system furthermore provides, where desired, a "tonnage" signal which is unnecessary on this section as no train is operated which cannot regain headway after having come to a stop at any of the signals.

#### Control of Train Movements

Train dispatchers at Hoboken direct all train movements over this stretch of track. Three levermen, but no directors, are employed at each of the following towers: Newark, Newark drawbridge, Harrison, Kearny Junction and lower Hackensack drawbridge. Telephones and train describers are used between towers to facilitate train operation.

The bulletin placing the Meadows signaling in service contains the following provisions: "Current of traffic will be authorized only by interlocking block signals. Engine-men will receive signal indications as per track assignment." In other words, traffic direction is provided by signal indication. The direction of traffic may be changed

as required by operating conditions. Under such conditions the levermen obtain a release from the adjoining tower on the proper traffic lever and reverse the desired signal levers.

#### Power Supply

The regular source of power supply is the railroad company's 6,600-volt, 3-phase, 60-cycle transmission line, which extends across the Meadows and from which taps are taken at two places, as indicated in Fig. 4, Hackensack drawbridge and Harrison sub-station, just east of the Passaic river. Normal connection is made at the Harrison sub-station. An emergency supply is provided by the public service, 2,400-volt, 2-phase, 60-cycle line, which is converted to 3-phase and the proper voltage by the use of Scott-connected transformers.

The emergency supply of power is cut in automatically at any time when there is a failure of the normal supply, through the agency of a General Electric automatic sub-station. The time required for a complete change-over is approximately one-half second. Circuit controllers are interlocked in such a way as to prohibit single phasing. The change-over is effective not only upon the failure of normal supply, but also whenever the secondary voltage falls as low as 95. Restoration of the connection to the normal supply is made manually.

The three 6,600-volt transmission wires are carried

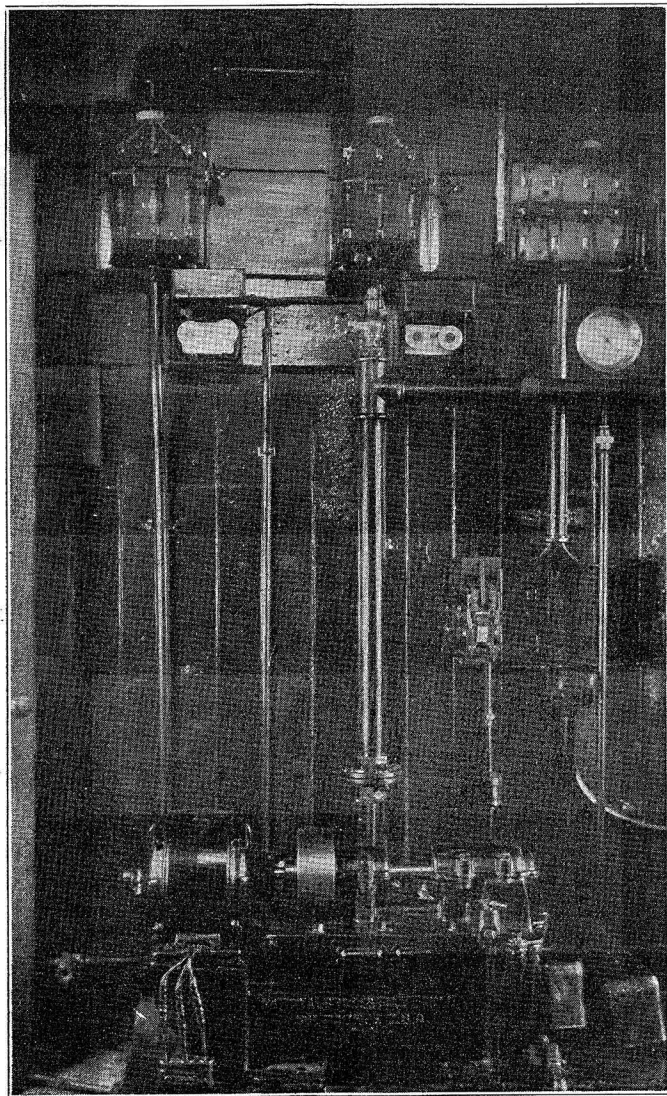


A Portion of the Switching Apparatus in the Substation Just East of Newark

on the same poles as the power department line of the same voltage. It will be noted that it was necessary to use aerial cable at Sanford's Crossing, and submarine cable under the Passaic river. With the exception of these two locations, transmission wires are carried on porcelain insulators. Nineteen 5-kva. transformers supply the entire signal load. Those transformers are located on the line poles and are protected by means of General

Electric compression chamber lightning arresters and choke coils.

The signal transmission line is sectionalized at Sanford's Crossing, Kearny Junction and Harrison towers, at which points air-break sectionalizing switches are used. In sectionalizing, any of the locations mentioned can be fed from either direction. This allows for opening a



One of the Air Compressors in the Newark Plant, Showing Also the Automatic Controller, Overload Fuses and the Enclosed Type Safety Switches with Covers Removed

section of transmission line for repairs without suspending service at any interlocking. Arrangement is provided for the Newark interlocking to be fed from either the signal transmission line or from the railroad power department line.

#### Interlockings

The arrangement for supply of energy to the interlockings is remarkably simple. In the first place, no battery is required as all parts except track circuits are arranged for alternating current supply. There being no battery, no charging equipment is required. The air compressors and pneumatic-electric controllers were furnished by the National Brake & Electric Co., Milwaukee, Wis. These machines are the type H-1 with a rated piston displacement of 12.2 cu. ft. of free air a minute.

The motors are Westinghouse 110-volt, 3-phase, 60-cycle, developing a maximum of 2 h.p. A simple centrifugal motor clutch enables the motors to start easily with-

out a load. An automatic controller provides for a cut-in cut-out at 45 lb. and 60 lb. respectively. Two compressors were installed at each of the Newark, Harrison and Kearny Junction plants, while there is but one at Hackensack drawbridge. The average consumption of air at each plant is less than  $2\frac{1}{2}$  cu. ft. of free air a minute. The compressors run approximately 20 per cent of the time. This low requirement of compressed air is brought about by the use of modern electro-pneumatic apparatus.

The supply of energy is so simply arranged that it was not considered necessary to install switch boards. The knife switches for controlling supply to the air compressor motors, the interlocking machine, and plant are suitably mounted in safety panel-boxes attached to the tower wall.

The Union Switch & Signal Company's Model 14 power interlocking machines at all four plants are similar. Taking the Harrison machine as an example, there are:

- 8 levers for 15 switches
- 9 levers for 27 signals
- 4 traffic levers
- 1 lever for outlying switch lock

- 22 working levers, total
- 1 spare lever

23 lever machine.



A Portion of the Relay Case in the Newark Plant

It will be seen that 22 levers handle 47 units. This interlocking machine is less than 6 ft. long and its levers can be easily manipulated by one man, an economical factor where traffic is so heavy.

The indication and lock magnets are energized at 110 volts, 60 cycles. All switch levers are equipped for electric detector locking. Traffic levers have a single lock magnet. All signal levers are three-position. A 3-light



lever indicator cabinet extends the entire length of the machine. Green roundels are used except for the bottom row of lamps under signal levers, which are equipped with red prism glass for a special signal indication. The lever lamps are 12-volt. Push buttons of the mechanical stick type are provided for all signals. Mercury time releases operate in conjunction with dwarf signal levers.

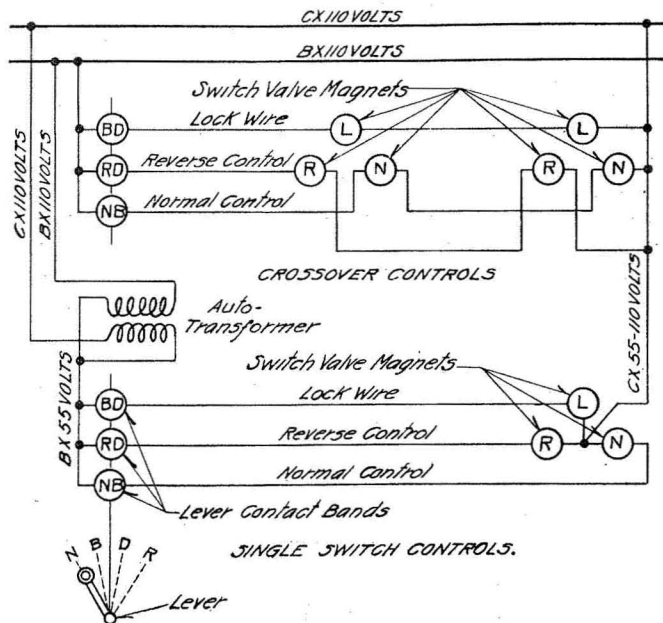
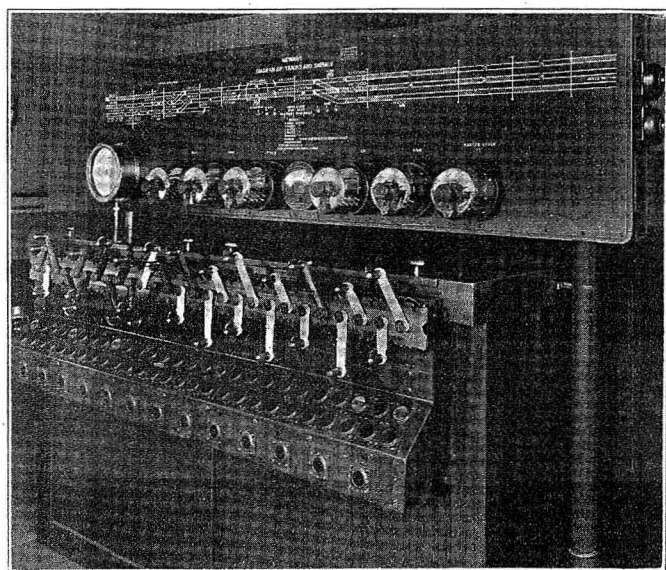


Fig. 5—Switch Control Circuits

One push button is provided for controlling air whistles located on the signal bridges, with which trains can be stopped in emergency. Also with the whistle a main-tainer can be called to a nearby 'phone from any location.

#### Track Models

The interlocking machine is self-contained and is completely enclosed in an enameled sheet steel case which



Interlocking Machine With Track Model at Newark, N. J.

has removable panels. The panels are equipped with cabinet locks which prevent access to the machine by other than authorized persons.

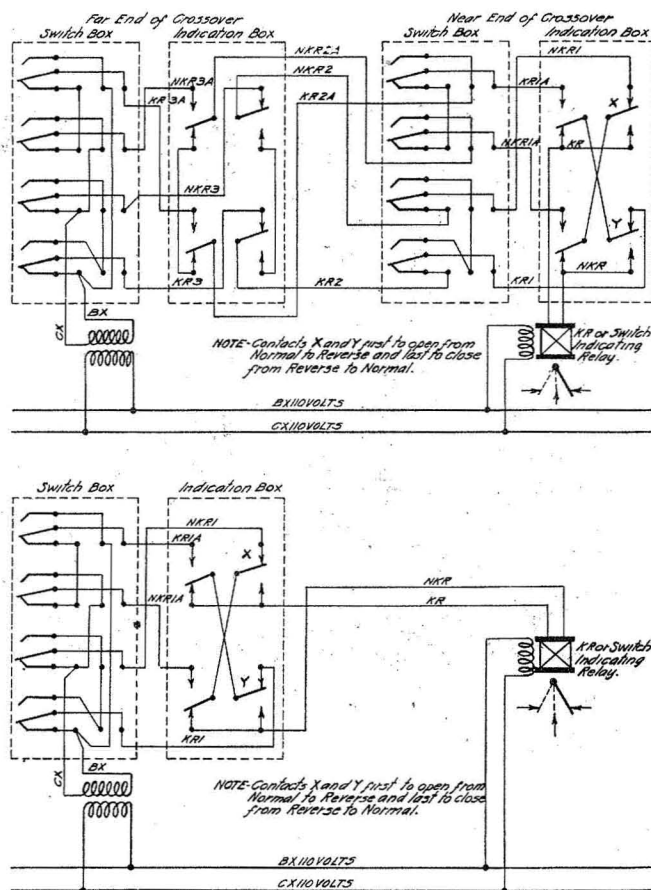
Track models are provided for all of the power interlockings. These are of sheet steel mounted on angle iron frames and supported from the floor on 2-in pipe

posts. Tracks, letters and figures are in white on a flat background. This combination in non-reflective finish is the clearest and best when spotlights are used to indicate track occupancy. Twelve volt telephone type lamps, behind frosted bull's-eyes, indicate by their illumination that trains are not on the various track sections. Because of the short length blocks and consequent brief interval of time for indicating a train approaching a signal, a four-block indication is provided approaching home signals.

The track models are located directly over the interlocking machines, and so provide a location where recording air gages, ground and phase indicating lamps are most readily discernible, and where train describers and clock-work time releases are easily accessible.

#### Switch Movements

Type A-1 electro-pneumatic switch movements are used exclusively. This movement is equipped with a cylinder



Switch Indication Circuits for Cross-Over  
Switch Indication Circuits for Single Switches  
Fig. 6—Switch Indication Circuits

having a 12-in. stroke and of sufficient capacity to handle any switch, slip, derail or frog points at 40 lb. air pressure. The switch movements are controlled by means of Style "C" cutoff type valves. The combination of reduced air pressure and normal cutoff of the air supply to the switch cylinder at the valve, results in a very considerable saving of compressed air, as is indicated by the small size compressors.

The switch control circuits are shown in Fig. 5. Similar valve magnets of cross-over or switch and derail movements are connected in series and supplied with energy at 110 volts. Fifty-five volts for the single switch valve magnets is supplied by means of a simple auto-transformer connection.

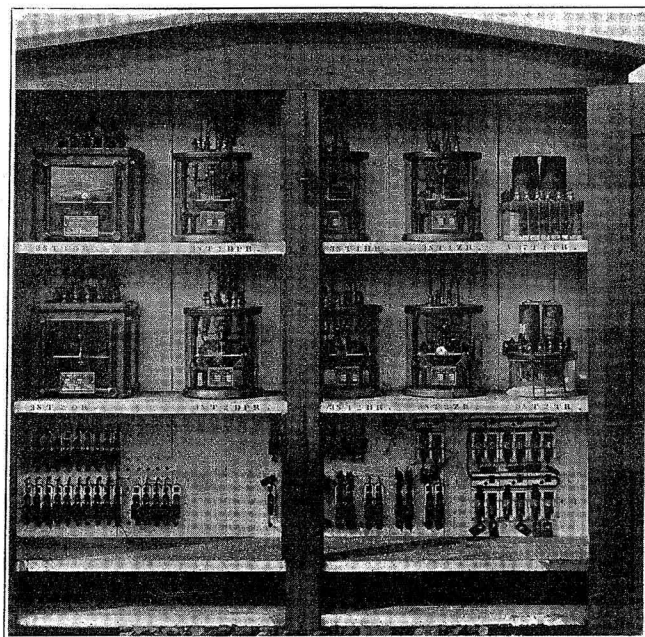
The *KR* (indication) relays are Model 15 three-position vanes, and have contacts through which the signal control circuits are broken, thus providing by the *SS* scheme, continuous control of all signals by all switches and derails over which they govern train movement. Energy for the *KR* relays is supplied by individual indication transformers located at the switches, as shown in Fig. 6.

### Signals

Union Style "L" color light signals are used throughout. The aspects and indications have been described and the construction as well as the mounting of these signals is clearly indicated in the accompanying views. The long range of this signal is secured by the use of an accurately based concentrated filament lamp. Provision is made for this lamp burning out and the short range indication improved by a pilot lamp which has an ordinary filament. Individual lamp transformers make possible relay control at 110 volts and the use of a rugged filament 6-volt lamp which provides long life. The colors used in the lenses are darker than the Signal section A. R. A. standards, thereby providing satisfactory range without any filtering out of the colors, which might otherwise accompany the use of concentrated filament lamps. As a result of a number of tests, a minimum spacing of 4 ft. was established between signal units which might be illuminated simultaneously. This spacing gives ample protection from blurring.

The interlocking signal control and indication circuits are the same as for standard electro-pneumatic or Type "F" electric interlocking, but with such additional control selection as is made necessary by the three-block signal indications. One special feature of the signal indication circuit is the illumination of the red prism glass under the lever when a signal indicates "Stop" after having been cleared for train movement. Thus the leverman is in-

formed when a train passes the signal, independently of the track model, and knows the instant a high signal lever can be returned to normal. The light is put out by returning the lever to its normal (central) position.



Relay Box at Sanford Crossing

Typical circuits for the automatic signals are shown in Fig. 7. The three-block indication and traffic reversal makes these somewhat more complicated than would be the case for simpler signaling. "Light-out" relays make it impossible for a less restrictive indication to be given

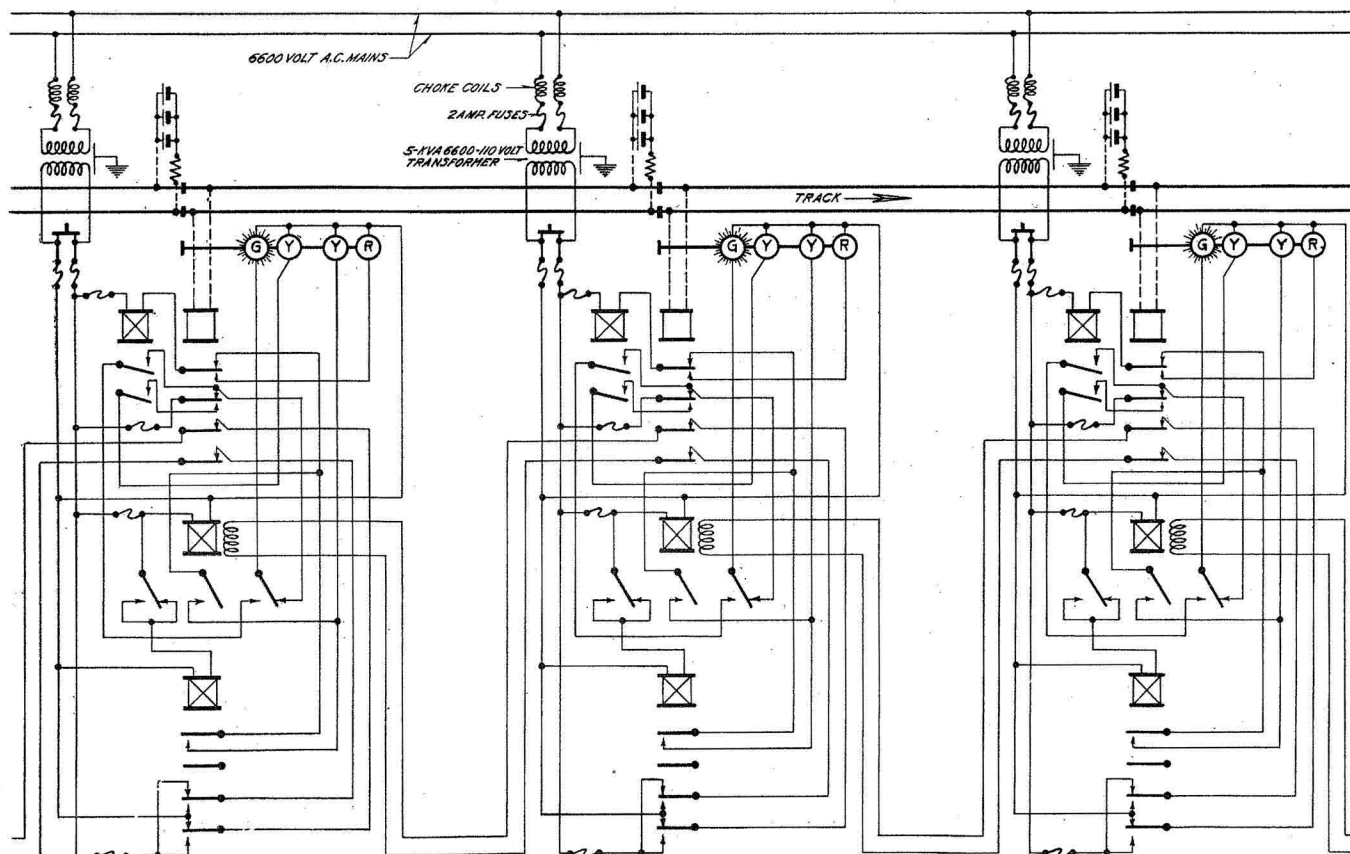


Fig. 7—Automatic Block Signal Control Circuit With All Apparatus Normal and Signals Indicating Clear

